 

Description

Method for communication by means of a plurality of network-side transmission antennas

The invention relates to a method for communication in a radio communications system in accordance with the preamble of claim 1. Furthermore the invention relates to a network-side device and a computer program product for executing the method.

In radio communications systems messages such as signaling messages or user data messages with speech information, picture information, video information, SMS (Short Message Service), MMS (Multimedia Messaging Service) or other data for example, are transmitted with the aid of electromagnetic waves over a radio interface between transmitting and receiving station. The stations can in this case, depending on the concrete embodiment of the radio communications system, involve diverse types of subscriber-side mobile stations and network-side radio devices. In a mobile radio communications system at least one part of the subscriber-side radio stations is mobile radio stations. The electromagnetic waves are emitted with carrier frequencies which lie in the frequency band provided for the relevant system.

Mobile radio communications systems are often embodied as cellular systems in accordance with the GSM (Global System for Mobile Communication) or UMTS (Universal Mobile Telecommunications System) standard with network-side devices such as base stations and devices for checking and controlling the base stations.

As well as these cellular, hierarchical radio networks organized on a wide-area (supralocal) basis, there are also

Wireless Local Area Networks (WLANs) with a radio coverage area that as a rule is far more limited. The cells covered by the radio access points (AP) of the WLANs, with a radius of up to a few hundred meters, are small by comparison with usual mobile radio cells. Examples of different standards for WLANs are HiperLAN, DECT, IEEE 802.11, Bluetooth and WATM.

Whereas in many radio communications systems a series of network-side antennas, as a rule arranged centrally per cell, is used for transmission of messages to mobile stations, it is also possible to use a plurality of network-side antennas. Messages for mobile stations can then be emitted simultaneously via a plurality of network-side antennas. If a message is emitted to a mobile station via a plurality of network-side antennas, this sometimes causes disturbing interference for message transmission to other mobile stations located in the vicinity. It is thus advantageous to only emit messages for a mobile station via a restricted number of network-side antennas.

The object of the invention is to present an efficient method for communication in which a message is sent via a plurality of network-side antennas to a mobile station. Furthermore a network-side device and a computer program product for a network-side device for executing the method are to be proposed.

This object is achieved, as regards the method, by a method with the features of claim 1. The object is achieved in respect of the network-side device and the computer program product by a network-side device and a computer program product with the features of the subclaims.

Advantageous embodiments and further developments are the object of the subclaims.

The method is employed in a radio communications system which comprises network-side devices and mobile stations. A message of a mobile station is received by network-side antennas. Subsequently a user data message is transmitted via a plurality of network-side antennas to the mobile station. In accordance with the invention the association between the network-side antennas and the plurality of network-side antennas depends on the network-side antennas which have received the message of the mobile station. The message received on the network side involves a response message sent on receipt of a signaling message. The signaling message requests the mobile station to send a response message and is transmitted via at least one network-side antenna to the mobile station.

The network-side devices of the radio communications system can for example be network-side antennas, devices for control of the antennas and devices for creating messages to be transmitted and for processing received messages. The mobile stations can comprise different types of, especially mobile, user stations. By preference the radio communications system can involve a cellular system, with each radio cell featuring one or more network-side antennas. With a number of network-side antennas per radio cell all network-side antennas of the relevant radio cell are connected to a network-side device which transmits to the network-side antennas messages to be emitted. Network-side antennas of various radio cells receive the messages to be emitted by them from different network-side devices.

The message of the mobile station, on the basis of the reception of which a decision can be made on the network side about the network-side antennas via which a user data message to be transmitted in the future is to be transmitted to the

mobile station, can in particular include identification information of the mobile station. After the evaluation of the network-side antennas via which the message of the mobile station was received, a user data message is sent to the mobile station via a plurality of antennas. The composition of the plurality of network-side antennas, i.e. the question of which network-side antennas make up the plurality of network-side antennas, can be defined so that all those network-side antennas which have received the message of the mobile station or have received it with a minimum receive level, send the user data message to the mobile station. However in addition to the criterion covering which network-side antennas have received the message of the mobile station, further criteria for defining the plurality of network-side antennas can be used, such as a minimum or a highest number of network-side antennas to be used, a utilization of network-side antennas and/or a geographical or cell-related distribution or arrangement of the network-side antennas.

It is advantageous for the network-side antennas of the plurality of network-side antennas to be located at different positions within of the radio communications system, i.e. to be separated by distances which are large in relation to the wavelength used for radio transmission. In a cellular system for example the network-side antennas of a cell can be distributed approximately evenly over the cell. Preferably the user data message is transmitted to the mobile station over the plurality of network-side antennas with synchronous or at least approximately synchronous timing or with network-side defined time differences between the transmission of the user data message via the individual network-side antennas.

It is advantageous if the signaling message is transmitted via a group of network-side antennas, with this group comprising

the plurality of network-side antennas via which the user data message will subsequently be sent to the mobile station. The signaling message can especially include identification information of the mobile station.

The mobile station is explicitly requested to transmit the message which can then be used on the network side for selection of suitable network-side antennas for transmission of messages to the mobile station. In particular it is possible for the signaling message to be transmitted exclusively for the purposes of requesting the response message.

Preferably the signaling message is transmitted at regular first time intervals. It is also possible for the signaling message to be transmitted to the mobile station before the user data message is transmitted, on the condition that a specific period of time has elapsed since the last transmission of a message of the signaling message type. The last-mentioned embodiment then makes it possible, if there is a user data message available on the network side for the mobile station, to check the last time that the network-side antennas which were to be used for transmission were determined. If this last determination was longer ago that the second time interval, a signaling message can be sent in order to define the suitable network-side antennas before the user data message is transmitted. The combination of the regular transmission of the signaling message with a transmission of the signaling message for a concrete reason, i.e. with the check as to whether the signaling message is to be transmitted before a user data message transmission, is also possible.

It is possible for the signaling message to be sent via all network-side antennas of one or more radio cells of the radio

communications system or via all network-side antennas of the radio communications system. The decision about the network-side antennas via which the signaling message is sent to the mobile station can be made dependent on how precisely the current position of mobile station in the radio communications system is known.

Furthermore it is possible for the plurality of network-side antennas to belong to the same radio cell of the radio communications system, or for at least some of the network-side antennas of the plurality of network-side antennas to belong to different radio cells of the radio communications system. This enables handover processes between different radio cells to be simplified.

In a preferred embodiment of the invention the signaling message includes identification information of the relevant radio cell about the network-side antenna or antennas of which it is transmitted, and the response message comprises identification information of that radio cell or those radio cells from the network-side antenna or antennas of which the mobile station has received the signaling message. If the signaling message is emitted via network-side antennas of a plurality of radio cells, the signaling message enters different cell-specific identification information in each case in these radio cells. If the mobile station merely receives the signaling message via network-side antennas of a single radio cell, the response message contains identification information from this radio cell only. If on the other hand the mobile station receives the signaling message via network-side antennas of a first and a second radio cell, the response message contains identification information of both radio cells.

The features of the inventive network-side device are as follows: Means for receiving via network-side antennas a message of a mobile station or for receiving information about the receipt via network-side antennas of a message of a mobile station, with the network-side received message involving a response message about the receipt of at least one signaling message transmitted on a network-side antenna to the mobile station (MS) requesting the mobile station to send a response message,
Means for arranging that the user data message is sent via a plurality of network-side antennas to the mobile station, and
Means for determining whether network-side antennas belong to the plurality of network-side antennas, depending on which network-side antennas have received the message of the mobile station.

The means present in the network-side device can especially be implemented by a computer program product. A computer program within the context of the present invention is taken to mean, as well as the actual computer program (with its technical effect extending beyond the normal physical interaction between program and processing unit) especially a means of recording the computer program, a collection of files, a configured processing unit, but also for example a memory device or a server, on which the file or files belonging to the computer program are stored.

The inventive network-side device and also the inventive computer program product are especially suitable for executing the method in accordance with the invention, with this also applying to the embodiments and developments. To this end the invention can feature further suitable means. The inventive network-side device can also be implemented by a plurality of network-side devices connected to each other, which feature

the relevant means.

The invention is explained in greater detail below with reference to an exemplary embodiment. The Figures show:

Figure 1: a section from a radio communications system,

Figure 2: a first sequence diagram of an inventive method,

Figure 3: a second sequence diagram of an inventive method,

Figure 4: a schematic diagram of the structure of an inventive network-side control device.

In Figure 1 two radio cells FZ1 and FZ2 of a radio communications system are depicted by cloud symbols. Located in the first radio cell FZ1 are the three distributed network-side antennas ANT-A, ANT-B and ANT-C which are connected to the first control device APS1 (APS: Antenna Processing Station). Whereas the antennas ANT-A, ANT-B and ANT-C are responsible for receiving and transmitting messages from or to mobile stations, such as the mobile station MS for example, any processing of radio signals is undertaken in the processing station APS1. The same applies to the second radio cell FZ2, in which the two network-side antennas ANT-D and ANT-E are connected to the second processing station APS2. The two processing stations APS1 and APS2 are connected to each other via further devices if necessary. Further radio cells, infrastructure devices and subscriber-side mobile stations are not shown in Figure 1 for reasons of clarity.

A radio cell here means the geographical area which is covered by those network-side antennas which are connected to a shared processing station. Antennas of different radio cells are thus not directly connected to the same processing station. Different radio cells can overlap with each other.

If a message is sent in a downstream direction to the mobile station MS, the transmission is undertaken simultaneously via a plurality of network-side antennas. The mobile station MS can combine the signals of the different network-side antennas and thus decode a message more reliably than by transmission via a single network-side antenna. In this case it is advantageous to only transmit a message via those antennas of which the signals can be received by the mobile station MS as a result of its current location. If antennas other than these are used, unnecessary interference for messages of other user stations is created.

In order to determine the antennas via which a message is to be transmitted to the mobile station MS, different methods are proposed. Figure 2 shows an execution sequence of the first procedure. At the beginning the mobile station MS broadcasts a message MESSAGE which contains its identification information. The message MESSAGE is received by those antennas which are located within the radio coverage area of the mobile station MS. It is assumed that the radio coverage of the mobile station MS and that of the network-side antennas ANT-A, ANT-B, ANT-C, ANT-D and ANT-E is about the same size. Figure 2 shows the case in which the message MESSAGE is received by the antennas ANT-A, ANT-B and ANT-C. This arrangement can for example roughly correspond to the position of the mobile station MS shown in Figure 1. With the messages INFORM the three antennas ANT-A, ANT-B and ANT-C notify the processing station APS1 that they have received the message MESSAGE from the mobile station MS or the three antennas ANT-A, ANT-B and ANT-C forward the message MESSAGE of the mobile station MS to the processing station APS1. If there is a message DATA present on the network side for the mobile station MS, this is transmitted by the processing station APS1 to the three antennas ANT-A, ANT-B and ANT-C, which forward it to the

mobile station MS.

The mobile station MS transmits the message MESSAGE unsolicited at regular time intervals T-MS. Until the next transmission of the message MESSAGE the antennas ANT-A, ANT-B and ANT-C determined for transmission as a result of the receipt of the previous message MESSAGE are used for transmitting messages to the mobile station MS. The length of the time interval between the individual transmissions of the messages MESSAGE is notified to the mobile station MS by the network. In this case account can be taken of the fact that it is advantageous, when the mobile station MS frequently receives messages, to emit the message MESSAGE at short intervals. This allows the situation to be avoided in which messages are emitted all too often via antennas which the mobile station MS cannot receive. On the other hand, for the case in which messages for the mobile station MS are only rarely present, it is better to emit the message MESSAGE at longer intervals T-MS. This enables the signaling overhead which is created by transmitting the message MESSAGE to be reduced.

Figure 2 shows the case in which the next message MESSAGE sent by the mobile station MS is received by the antennas ANT-B, ANT-C and ANT-D. In relation to Figure 1 this would correspond for example to the arrangement whereby the mobile station MS has moved upwards and/or to the right. The antennas ANT-B, ANT-C and ANT-D inform the processing station with the messages INFORM that they have received the message MESSAGE of the mobile station MS or the three antennas ANT-B, ANT-C and ANT-D forward the message MESSAGE of the mobile station MS to the processing station APS1. The notification of the processing station APS1 by the antenna ANT-D can be undertaken via the processing station APS2 connected to the antenna ANT-

D. Alternatively it is also possible for the two antennas ANT-B and ANT-C to inform the processing station APS1 assigned to them, and the antenna ANT-D to inform the processing station APS2 assigned to it, after which the two processing stations APS1 and APS2 forward information the receipt of the message MESSAGE in their radio cells or the message MESSAGE to a shared network-side device, which then transfers to them the message DATA to be transmitted to the mobile station MS. The message DATA is then transmitted to the mobile station MS via the three antennas ANT-B, ANT-C and ANT-D.

A further procedure is shown in Figure 3. Whereas, in Figure 2, the mobile station MS transmits the message MESSAGE unsolicited, from the receipt of which the antennas to be used for transmission in the following messages to the mobile station MS are derived, at the beginning of the procedural sequence shown in Figure 3 there is the transmission of a message ADR (ADR: Antenna Detection Request) to the mobile station MS, by means of which the mobile station MS is requested, giving its identification information, to transmit a signaling message with its identification information. The message ADR is transmitted via the three antennas ANT-A, ANT-B and ANT-C to the mobile station MS. In this case it is assumed that it is known on the network side that the mobile station MS is located in the radio cell FZ1 or at least in the immediate vicinity of the radio cell FZ1. It is however also possible to emit the message ADR via the antennas of a plurality of radio cells or via all antennas of the radio communications system.

As a reaction to the receipt of the message ADR the mobile station MS transmits the message containing its identification information ADD (ADD: Antenna Detection Done), which is received by the antennas ANT-B and ANT-C. The antennas ANT-B

and ANT-C inform the processing station APS1 with the message INFORM that they have received a message ADR of the mobile station MS, or forward the message ADR of the mobile station MS to the processing station APS1. After this the message DATA is transmitted to the mobile station MS via the antennas ANT-B and ANT-C, which have received the message ADR from the mobile station MS.

The message ADR can be transmitted at regular intervals. It is however more advantageous for the message ADR to be emitted whenever there is a network-side message to the mobile station MS present. It is also possible, with the presence of a message to the mobile station MS, to check when the last message ADR was transmitted, and only to transmit a new message ADR if a specific period of time has elapsed since the last transmission.

The messages ADR can be equipped with identification information of the radio cell in which they were transmitted. If a message ADR is emitted in a number of radio cells, identification information is inserted into the message ADR in each radio cell appropriate to the radio cell concerned. If the mobile station MS then transmits a response ADD to the message ADR it inserts into the response ADD the identification information of those radio cells via the antennas of which it has received the message ADR. This is especially advantageous if the mobile station MS receives the message ADR from antennas of different radio cells. In this case it is known to the processing station of a radio cell from the evaluation of the message ADD that a mobile station can also receives antennas of other radio cells without this fact needing to be notified to the relevant processing station of by another processing station or another network-side device.

As an alternative or in addition to transmitting the messages ADR with the object of defining the antennas to be used for sending messages to the mobile station MS, the method described below which is depicted in the right-hand part of Figure 3 can be employed. After the receipt of a message DATA the mobile station MS confirms the receipt of the message DATA by transmitting a message ACK, which comprises identification information of the mobile station MS. Those network-side antennas which have received the message ACK, in Figure 3 the antennas ANT-B, ANT-C and ANT-D, use the message INFORM, as described above, to inform the processing station APS1 or the processing stations APS1 and APS2 about the receipt of the message ACK from the mobile station MS, or forward the message ACK from the mobile station MS to the relevant processing station APS1 or APS2. Subsequently the three antennas ANT-B, ANT-C and ANT-D are used for the next message transmission to the mobile station MS. The fact that the confirmation messages ACK of the mobile station MS are used for determining the future network-side transmit antennas means that no additional signaling overhead is involved since the confirmation messages ACK are generally transmitted independently of the inventive method. Furthermore the described application of the confirmation messages ACK enables the optimum antennas to be determined after each transmission of a message confirmed by the mobile station MS. This results, for a frequent transmission of messages to the mobile station MS, in an ongoing application of the method.

Figure 4 shows a schematic diagram of the layout of the processing station APS1. Via the means RECEIVE the processing station APS1 receives the messages INFORM or the message received by network-side antennas from network-side antennas. After evaluating the messages INFORM in the means DECIDE the processing station APS1 decides on the antennas via which a

message transmission is subsequently to be undertaken to a mobile station. Via the means INSTRUCT the corresponding antennas defined using the means DECIDE are notified that they are to transmit a message to the relevant mobile station. Accordingly a network-side device is also set up for the case in which a message is to be transmitted to a mobile station via antennas of different radio cells. The means RECEIVE do not then receive the messages INFORM or the messages received in the various radio cells directly from the network-side antennas, but via the processing stations assigned to the antennas concerned. In a similar way the means INSTRUCT does not communicate directly with the network-side antennas, but with the processing stations assigned to the relevant antennas.